

GEOGRAPHIC INTELLIGENCE REPORT

SELECTED OBSERVATION POINTS IN THE
SEMPALATINSK REGION



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16 May 1957

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I. The Problem

The purpose of this study is to select favorable observation points in the vicinity of the Semipalatinsk nuclear testing range. The testing area is located on the northern flank of the Central Kazakh Highlands, an extensive steppe and semidesert area of rolling hills and scattered mountains. Ground zero, the point on the earth's surface directly below the nuclear explosion, is assumed to be located at 50°N-78°E. The presence of many elevated points in the testing area and also in the higher mountains farther to the south and east provides several observation possibilities worthy of analysis.

It is assumed that the nuclear cloud phenomenon may rise as high as 100,000 feet above sea level. If a direct line of sight were required to ground zero itself, or even a point 2,000 feet above ground zero, the potential observation points would be restricted to the immediate vicinity of the explosion. Reasonable precautions for the safety of the observer would seem to require that he be no closer than 100 miles* to ground zero. This figure is based on consideration of the blast wave and thermal and radiation effects of the explosion, together with the probable tight nature of the surrounding security cordon. Allowance must also be made for a change in the position of ground zero, assuming that not all of the explosions take place at exactly 50°N-78°E.

*All distances in statute miles, unless otherwise specified.

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The curvature of the earth becomes a dominant factor in considering a direct line of sight between the observer and the phenomenon. As can be seen from the sketch and table in Figure 1, an observer would have to be 800 feet above sea level to sight an object on the horizon 34.5 miles distant, would have to be at 3,193 feet elev. if the distance to the object is 69.0 miles, etc. When the distance appreciably exceeds 100 miles, the elevation requirement created by the earth's curvature cannot be met by existing elevations of mountain peaks surrounding the test area. Moreover, the nature of the intervening terrain tends to elevate further the direct line of sight. It becomes necessary, therefore, to reverse the problem and to consider the necessary altitude that the phenomenon must attain to be visible from existing high and favorably situated distant observation points. In this study, altitudes of the phenomena above sea level up to 100,000 feet and distances up to 440 miles are considered.

25X1C

25X1C Although peak elevations up to 13,000 feet are used in the computations, [REDACTED]

[REDACTED] Some of the summits may already be occupied by Soviet observation stations; in the case of others, only an accomplished mountain climber might be able to reach the summit. The natural conditions at selected observation points are summarized in Table 2.

II. Determination of Favorable Observation Points

From preliminary general considerations, it is evident that the earth's radius is very large in comparison with the elevations above sea level of the cloud phenomenon, the observer, and the intervening limiting topographic feature. Figure 2 shows that a triangle can be formed whose sides consist of two radii of the earth extended to the

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elevations of the cloud phenomenon (or object) and of the observer (R_o+h, R_o+q) and the line of sight between object and observer. Somewhere on the line of sight will be the topographic feature which determines the lowest possible line of visibility to the object. A third radius of the earth is extended to the top of this feature (R_o+p), forming the central angles ϕ and ψ with the object and observer. Application of the trigonometric laws of sines and cosines to the triangles of the figure yields the simple formula:

$$\frac{\sin(\phi+\psi)}{R_o+p} = \frac{\sin \phi}{R_o+q} + \frac{\sin \psi}{R_o+h}$$

The variables in this formula are ϕ, ψ, p, q and h . The value of R_o at the latitude of ground zero can be calculated from tables for any desired ellipsoid of reference. The precise value of R_o has little effect upon the final results obtained. Values of ϕ and ψ are calculated from measurement made on a large-scale map after the location and elevation of the obstructing topographic feature are determined; q is the elevation above sea level of the observer's station or peak as determined from a large-scale map. The only unknown in the equation thus becomes h , which then can be calculated from the formula. Since p, q and h are very small compared with R_o , it is necessary to use trigonometric tables to 7 places to obtain dependable values for h .

Figure 3 shows that none of the three radii of the earth, when extended to include p, q and h , are necessarily perpendicular to the line of sight. The figure further shows that, when distances of several hundred miles are involved between observer and object, the limiting topographic feature must be as far removed from the observer as possible.

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An analysis was made of 13 potential observation points, all in lower latitude than the test area. These points are located on the accompanying map. Some uncertainty arises in connection with the selection of the intervening topographic feature that limits the vision of the observer in the direction of the object. It then becomes necessary to apply the formula more than once. Considerable uncertainty is also involved in assigning an appropriate elevation figure in cases where the terrain is relatively flat and is undifferentiated on the map. The results obtained for each of the 13 points studied are shown in Table 1. Elevation or altitude figures are to be considered somewhat approximate, since source maps* at scales of 1:1,000,000 and 1:500,000 cannot show elevations reliably.

From this analysis, it may be concluded that a reasonable maximum distance for observation points is 450 miles from ground zero. Even in this case the nuclear cloud would have to be about 100,000 feet above sea level. If the primary purpose of the operation can be achieved by observation of clouds at elevations of 10,000 feet and higher, plausible observation points would have to be located within 100 and 450 miles of ground zero. After eliminating some of the selected sites for various reasons, it would be well to re-examine the remaining sites more critically in order to determine the extent to which small changes in the

*Elevation data based on relief shown on the following maps:

1. Army Map Service; I.M.W. Series; 1:1,000,000; Sheets NL 43 (1950), NL 44 (1943), NM 43 (1950), NM 44 (1956), NM 45 (1955).
2. NKVD, SSSR, Sibirskaya Kartograficheskaya Fabrika No. 5; Kazakhskaya SSR (topographic series); 1:500,000; Sheets M-43-B, M-43-D, M-44-A, 1936 (CIA G000-30, 22965).
3. GUGK, MVD SSSR; Soyuz Sovetskikh Sotsialisticheskikh Respublik, (physical map); 1:5,000,000; Moscow, 1955 (CIA G000-22, 96684).

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observer's location or ground zero might affect the observer's capability to make the desired observations. Also, if the position of ground zero is elsewhere than at the assumed location at 50°N-78°E, a different obstruction would probably be introduced and the line of sight would be altered accordingly, thus making new computations necessary.

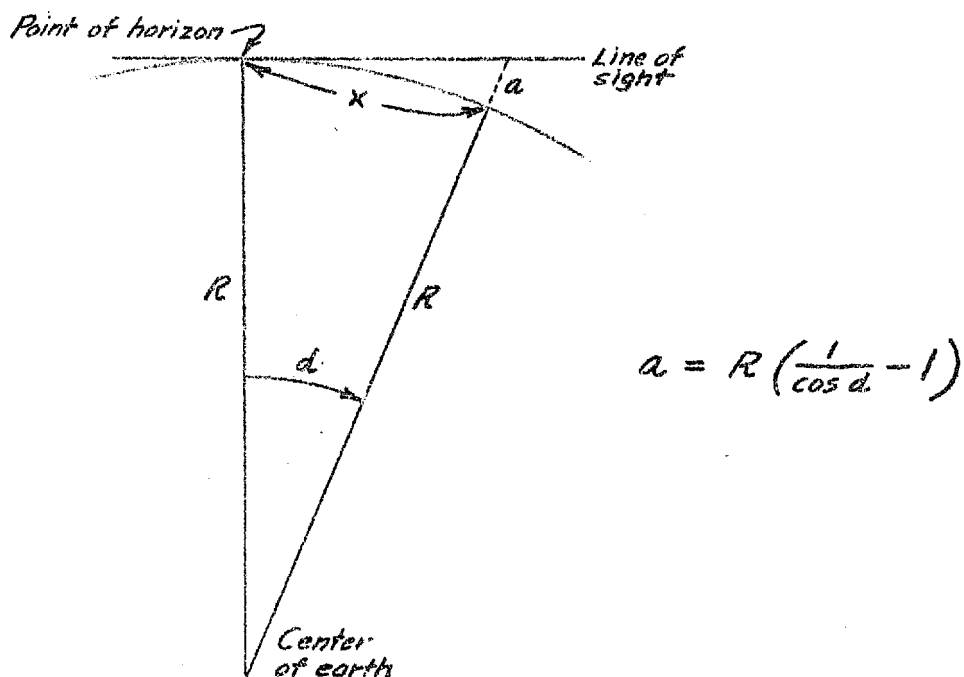
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Figure 1

Relation Between Altitude and Distance
to the Visible Horizon



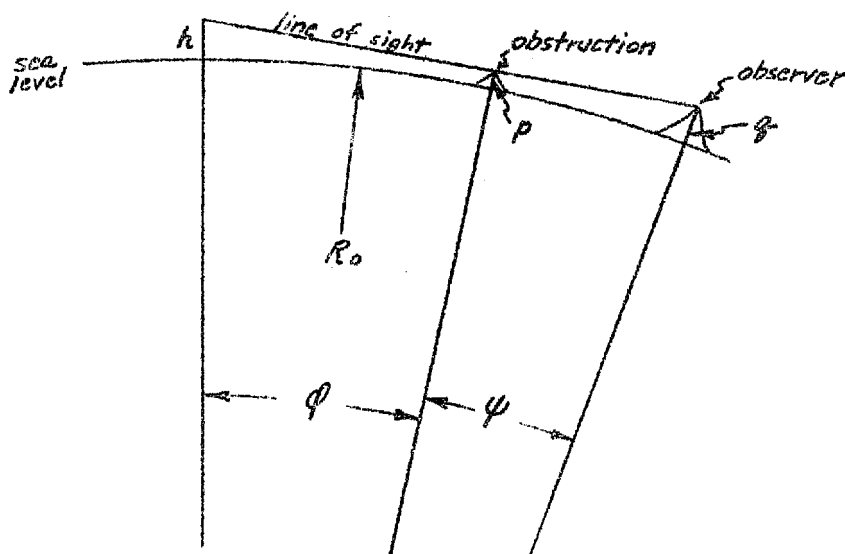
<u>d (degrees)</u>	<u>x (statute miles)</u>	<u>a (altitude in feet)</u>
0°-30'	34.5	800
1°—	69.0	3,193
1°-30'	103.5	7,188
2°—	138.0	12,593
2°-30'	162.5	19,975
3°—	207.0	28,775
3°-30'	241.5	39,181
4°—	276.0	51,198
4°-30'	310.5	64,835
5°—	345.0	80,090

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Figure 2

Formula for Calculating "h"



$$\frac{\sin(\phi + \psi)}{R_0 + p} = \frac{\sin \phi}{R_0 + q} + \frac{\sin \psi}{R_0 + h}$$

h = elevation in feet of object above sea level

p = elevation in feet of obstruction above sea level

q = elevation in feet of observer above sea level

R_0 = radius of earth to latitude of object

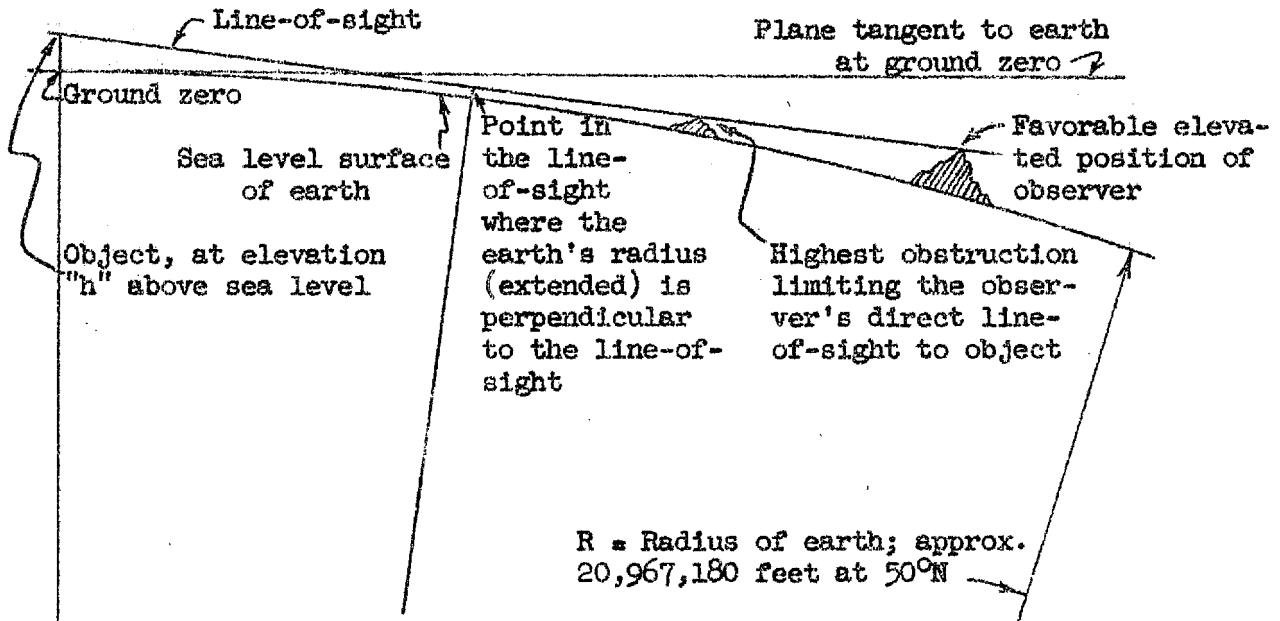
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Figure 3

Line-of-Sight Observation Close to
the Earth's Surface



From the above figure it is evident that in order to observe the object at the lowest possible elevation, the point where the earth's radius is perpendicular to the observer's line-of-sight should be as far removed from the observer as possible. This condition is fulfilled when the observer is on a relatively high station overlooking a low plain 50 to 100 miles in extent.

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